

Intercropping bean cultivars with plantain^{1,2}

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ABSTRACT

Two bean (*Phaseollus vulgaris* L.) cultivars, Arroyo Loro and DOR 364, and four lines, 9443-1, 9443-8, 9443-33, 9226-17, were intercropped once or twice with one cycle of plantain cultivar Maricongo at the AES-UPR Corozal substation during 1994-1995. The first cycle of beans intercropped at the time of plantain planting produced a high yield. The second cycle of beans intercropped two months before the termination of plantain harvest yielded poorly. The height of intercropped plantain plants was less than that of non-intercropped plantain plants ($P < 0.05$) at six months after planting. However, at 12 months, there was no height difference between them. There was no significant difference in diameter of pseudostem, nor in number of leaves, between the intercropped and the non-intercropped plantain plants. Plantain yields, in terms of number of fruits and bunch weight, were not significantly affected by the intercropping ($P < 0.05$). The highest net income of the intercropping treatment was derived from the first cycle of the bean line 9443-1 (\$7,646/ha). This net income represents an additional income of \$4,894/ha beyond that of plantain monoculture.

Key words: intercropping, bean, plantain

RESUMEN

Intercalando habichuelas con platano

Durante el año 1994-1995, dos cultivares de habichuelas, Arroyo Loro y DOR 364, y cuatro líneas 9443-1, 9443-8, 9443-33 y 9226-17, se intercalaron una o dos veces dentro de un ciclo de siembra de plátanos en la subestación de Corozal, EEA-UPR. La primera siembra de habichuela intercalada se estableció al momento de la siembra de los plátanos, obteniéndose una buena producción. La segunda siembra de habichuela intercalada se estableció dos meses antes de terminar la cosecha de plátanos, obteniéndose un rendimiento menor que en la primera siembra. A los seis meses después de la siembra, las plantas de plátanos no intercalados eran significativamente más altas que las plantas de los plátanos intercalados. Sin embargo, 12 meses después de la siembra no había diferencia significativa. Además, no hubo diferencias entre los plátanos intercalados y no intercalados en el diámetro del pseudotallo ni en el número de hojas de plátanos. El rendi-

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miento del plátano no se afectó por el intercalado. El mayor ingreso neto (\$7,646/ha) se obtuvo en el primer ciclo de la habichuela línea 9443-1 intercalada una vez con plátano. Este ingreso neto representa una ganancia adicional de \$4,894/ha sobre el ingreso neto del plátano en monocultivo.

INTRODUCTION

Intercropping is a widespread agronomic practice on subsistence farms in developing countries of the tropics (Francis et al., 1976). In southeastern Nigeria, plantain (*Musa acuminata* × *M. balbisiana*, AAB) is frequently intercropped with cocoyam (Devo et al., 1978) and cassava (Uzozie, 1971). In the Andean region of South America, plantain has been intercropped with coffee, cocoa, maize, cassava and bean (Stover and Simmonds, 1987). In Colombia, Valencia et al. (1995) conducted an intercropping experiment where plantain was intercropped with maize, cassava and bean. They reported that plantain yield was not affected by intercropping with any of the three above mentioned crops. Banana and plantain are frequently a permanent intercrop with coffee at populations of 400 to 1,000 plants per hectare in Columbia (Stover, 1983). The intercropping of cowpeas, maize and sweet potatoes with banana was studied in the West Indies by Rao and Edmund (1984). They did not find any significant reductions of banana bunch weight by the intercropping of the above mentioned crops. In Puerto Rico, Rodríguez et al. (1981) intercropped plantain with tanager at Corozal and reported that yield of tanager was reduced by 40%. However, they did not mention whether or not the plantain yield was reduced. In Puerto Rico, beans are already intercropped with plantains by a small number of farmers but there is no data concerning the economics of this practice. Neither is there any information available with regard to the field performance of the six bean cultivars under our specific intercropping conditions.

Since bean is a short term crop with some degree of shade tolerance, it may be suitable for intercropping with a long-term plantain crop. By the time the leaf canopy of plantain completely closes in, the bean crop will already have been harvested. More importantly, the long-term growing plantain requires 14 to 18 months to harvest a plant crop. This growth period represents a long wait for plantain farmers to recover their investment. Any additional income that can be earned from the same field during the wait for harvest would be financially attractive.

With this economic benefit in mind, we have conducted this field experiment at the AES Corozal Experiment Station to determine 1) the effect of intercropping on growth parameters and yield of plantain; 2) the economic benefit that can be derived from different bean cultivars and lines intercropped with plantain.

MATERIALS AND METHODS

A field experiment on bean-plantain intercropping was established on a Corozal clay (Clayey, mixed, isohyperthermic Aquic Haplohumults) 25 April 1994 at the AES, Corozal. The Corozal station is located in the north central part of the island. The Corozal clay soil has a pH of 5.0, and N, P, K, Ca, Mg content of 0.19%, 6 mg/kg, 1.35 cmol/kg, 3.95 cmol/kg, 0.70 cmol/kg, respectively. Two bean cultivars, Arroyo Loro and DOR 364, and four bean lines, 9443-1, 9443-8, 9443-33, 9226-17, were selected for the experiment. Treatments consisted of one bean-plantain intercropping (at the time of plantain planting), and two bean-plantain intercrops (at the plantain planting and two months before the end of plantain harvest). The plantain cultivar used was Maricongo. A plantain monoculture treatment was also included. All treatments were arranged in a randomized complete block design with four replications. Each plot contained six plantain plants with a planting distance of 1.8 × 2.7 m instead of the recommended distance of 1.8 × 1.8 m. This planting distance provides more space for the intercropping of beans. Eight 1.8-m-long rows of beans with row spacing of 51 cm were intercropped with two rows of plantain in each plot. The planting distance between the bean plants was 8 cm. The slope of the land used for this experiment was 15 to 20%. Both plantain and bean were planted perpendicularly to the down slope direction of the experiment. Fertilizer (10-05-20 with Sulpomag) was applied in 232, 309, 347 and 270 g/plant /application at 2, 5, 8, and 11 months after planting, respectively. The bean plants received one application of N, P, K fertilizer at a rate equivalent to 22, 11 and 22 kg/ha, respectively, two weeks after planting. All other agronomic and pest managements were in accordance with the recommended practices for growing plantains and beans (Irizarry and Montalvo, 1995; Beaver et al., 1992). A sprinkler irrigation system was used to supplement the natural rainfall. Growth parameters such as plant height, diameter of pseudostem and number of leaves per plant of the plantain plants, were recorded at the appropriate times. Bean plants were harvested nine weeks after planting. Plantain fruits were harvested at the mature-green stage during a time period of 12 to 18 months after planting. Yield data of both crops were subjected to analysis of variance and Duncan's Multiple Range Test ($P < 0.05$).

RESULTS AND DISCUSSION

Growth parameters

There was an initial height reduction of plantain plants at six months after planting in all intercropped treatments as compared to

the plantain monoculture (Table 1). However, this height reduction was no longer evident by the end of 12 months. There were no significant differences in diameter of pseudostem nor in number of leaves between the intercropped plantain plants and plantain monoculture.

Bean yield

The highest whole pod and green-shell bean yields were obtained with the 9443-33 and the 9443-1 bean lines during the first cycle of intercropping (Table 2). However, not all yield differences among treatments were significant. The same results were obtained for the total bean yield (Table 2). In general, bean yield of all lines and cultivars was considered good. Lower yields were obtained from all lines and cultivars of bean during the second cycle of intercropping (Table 2). The low bean yields obtained from the second cycle of bean contributed very little to the total yield. Apparently, the shading effect of plantain canopy and the falling of the harvested plantain pseudostems over the second cycle of intercropped bean plants, coupled with high rainfall that prevailed during the germinating period of beans, caused these low yields. Therefore, we do not recommend a second cycle of bean in-

TABLE 1.—*Effect of bean intercropping on growth parameters and yield of plantain cultivar Maricongo during 1994-1995.*

Treatment	Plant height at		Diameter of pseudostem	Number of leaves	Number of fruits	Fruit bunch weight
	6 mo.	12 mo.				
	m	m	cm	No/plant	No/ha	kg/ha
Arroyo Loro (one intercropping)	0.96c ¹	3.93a	18.3a	12a	76,987a	24,144a
9443-1 (one)	1.14bc	3.96a	18.7a	13a	92,020a	29,185a
9443-8 (one)	1.05bc	3.90a	18.5a	13a	74,330a	22,436a
9443-33 (one)	0.88c	3.84a	18.5a	13a	78,650a	24,660a
9226-17 (one)	0.91c	3.91a	18.8a	13a	78,066a	23,079a
DOR 364 (one)	0.97c	3.91a	18.3a	12a	64,281a	20,097a
Arroyo Loro (two intercroppings)	1.01bc	3.83a	18.9a	12a	73,500a	22,835a
9443-1 (two)	1.09bc	3.83a	18.4a	12a	89,030a	27,811a
9443-8 (two)	1.08bc	3.73a	18.2a	13a	74,414a	21,682a
9443-33 (two)	1.27b	3.93a	18.8a	13a	79,561a	26,057a
9226-17 (two)	0.97c	3.89a	18.2a	13a	75,909a	24,517a
DOR 364 (two)	1.05bc	3.97a	18.5a	13a	86,705a	26,583a
Plantain monoculture	1.85a	3.62a	18.5a	13a	73,831a	24,069a

¹Means followed by the same letter or letters do not differ significantly at $P < 0.05$.

TABLE 2.—Total and partial yields of two bean cultivars and four lines under two frequencies of intercropping with plantain (Maricongo), at Corozal during 1994-1995.

Cultivars	Whole pod yield			Green-shell bean yield		
	1st cycle	2nd cycle	Total	1st cycle	2nd cycle	Total
	----- kg/ha -----					
Arroyo Loro (one intercropping)	4,712abc ¹	—	4,712bcd ¹	2,387ab ¹	—	2,387ab ¹
9443-1 (one int.)	5,470ab	—	5,470ab	2,983a	—	2,983a
9443-8 (one int.)	2,668de	—	2,668e	1,451cd	—	1,451bcd
9443-33 (one int.)	3,619cde	—	3,619de	1,701bcd	—	1,701bcd
9226-17 (one int.)	2,169e	—	2,169e	1,104d	—	1,104cd
DOR 364 (one int.)	4,152bc	—	4,152cd	2,073abcd	—	2,073abc
Arroyo Loro (two intercroppings)	3,691bcd	191ab	3,882cd	1,796abcd	98ab	1,894abc
9443-1 (two int.)	3,941bc	164abc	4,105cd	2,040abcd	85abc	2,125ab
9443-8 (two int.)	3,192cde	118bc	3,310de	1,844abcd	61bc	1,905abc
9443-33 (two int.)	6,121a	85c	6,206a	3,565a	43c	3,608a
9226-17 (two int.)	1,683e	151abc	1,834e	907d	78abc	985cd
DOR 364 (two int.)	4,809ab	222a	5,031ab	2,042abcd	118a	2,156ab

Means followed by the same letter or letters do not differ significantly at $P < 0.05$.

tercropping toward the end of the plantain growing season. There was a minor infection of the angular leaf stain disease (*Phaeoisariopsis griseola*) among all lines and cultivars of bean tested. The 9443-33 line was noted for its high susceptibility to the golden mosaic virus in this experiment.

Plantain yield

No significant differences in number of fruits and bunch weight were found among the treatments (Table 1). Our finding that plantain yield was not affected significantly by intercropping is in agreement with the work reported by Valencia et al. (1995). Apparently, the initial height reduction in plantain plants observed at six months after planting was due to the competition for nutrients and water between plantain and bean plants. As soon as the bean plants were harvested, this competition no longer existed. Plantain plants were able to recover from this initial stress.

Economic feasibility

In this experiment, the highest net income (\$7,646/ha) was derived from one cycle of intercropping of bean line 9443-1 with plantain (Table 3). This net income represents an additional income of \$4,894 over that of plantain monoculture. It is important to note that not all bean cultivars produced higher net income than plantain monoculture. Therefore, the selection of high yielding bean cultivars for intercropping is of critical importance to profitability. In addition, farmers could receive reimbursement for supplementary wage payment of \$2.12 per hour from the Commonwealth Government of Puerto Rico.

For legal use under commercial intercropping conditions, a pesticide has to be registered for both plantain and bean crops. However, fenamiphos (Nemacur) is registered only for plantain, not for bean. Therefore, fenamiphos can not be used legally for the intercropped bean. Its use on plantain either will have to be delayed until after the harvest of bean or will have to wait until its registration for bean. The issue of pesticide usage for both intercropped crops is complex and will continue to be a problem for those farmers choosing to adopt this intercropping practice.

TABLE 3.—Gross and net incomes derived from one and two intercroppings of bean with plantain and plantain monoculture in a field experiment at Corozal Station, AES-UPR during 1994-1995.

Treatment	Gross income			Variable costs			Net income
	Bean	Plantain	Total	Bean	Plantain	Total	
	----- \$/ha -----						
Arroyo Loro (one intercrop)	8,474	10,648	19,122	7,024	7,862	14,886	4,236
9443-1 (one)	10,590	12,871	23,461	7,953	7,862	15,815	7,646
9443-8 (one)	5,151	9,894	15,045	4,949	7,862	12,811	2,234
9443-33 (one)	6,039	10,875	16,914	5,795	7,862	13,657	3,257
9226-17 (one)	3,919	10,178	14,097	4,366	7,862	12,228	1,869
DOR 364 (one)	7,359	8,863	16,222	6,419	7,862	14,281	1,941
Arroyo Loro (two intercroppings)	6,724	10,070	16,794	7,705	7,862	15,567	1,227
9443-1 (two)	7,544	12,265	19,809	7,591	7,862	15,453	4,356
9443-8 (two)	6,763	9,562	16,325	8,202	7,862	16,064	261
9443-33 (two)	12,808	11,491	24,299	10,534	7,862	18,396	5,903
9226-17 (two)	3,497	10,812	14,309	5,607	7,862	13,469	840
DOR 364 (two)	7,654	11,723	19,377	8,636	7,862	16,498	2,879
Plantain monoculture	0	10,614	10,614	0	7,862	7,862	2,752

Bean price was estimated at \$3.55/kg of green-shelled beans.

Plantain price was estimated at \$0.441/kg of fruit bunch weight.

Variable costs for beans were calculated on the basis of an estimated cost of \$7,065/ha.

Variable costs for plantain were taken from the "Conjunto Tecnológico para la producción de plátanos y guineos", Publicación 97. 1995 (Edición Revisada), FEA, UPR.

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